

Biobased Manufacture of Alkenyl Phenolics and Polysaccharide Feedstocks from Cashew Nut with Supercritical Water and Carbon Dioxide Processing

R. L. Smith, Jr.^{*a}, R. M. Malaluan^b, W. B. Setianto^c, H. Inomata^a, and K. Arai^b

^aTohoku University, Research Center of Supercritical Fluid Technology, Aoba-ku, Aza Aramaki, Aoba-07, Sendai 980-8579 Japan

Fax: 81 22 217 7293; smith@scf.che.tohoku.ac.jp

^bTohoku University, Graduate School of Chemical Engineering, Aoba-ku, Aza Aramaki, Aoba-07, Sendai 980-8579 Japan

^cMindanao State University - Iligan Institute of Technology

Dept of Chemical Engineering Tech., Andres Bonifacio Ave., Iligan City 9200

^dAgency for the Assessment and Application of Technology (BPPT)

MH. Thamrin 8 Jakarta 10340, Indonesia

The cashew tree (*Anacardium occidentale*) is a branchy evergreen tree native to tropical areas that grows in a wide range of soils and has a 25 year life span. Cashew nuts rank third in the the world production of edible nuts and represent a major source of alkenyl phenolic compounds. The fruit of the tree consists of an outer shell (epicarp), a tight fitting inner shell (endocarp), testa and the kernel. The pericarp of the fruit contains a strongly vesicant liquid that is mostly anacardic acids and cardols, which has to be removed before obtaining the valuable cashew nut kernel. In current cashew nut processing techniques, much of the phenolic liquid is wasted or damaged through heat treatment steps and many parts of the nut and tree are ineffectively utilized. As part of research philosophy, we are examining the application of supercritical fluids to improve the processing of renewable resources. In this work, we examining the reactive phase behavior of the cashew nut material and some of the phenolic liquid solubility characteristics.

Reactive phase behavior is the characteristic phase behavior of a material in the presence of a solvent during reacting conditions. The reactive phase behavior of many polymers and biological materials in water will be especially important in developing new agricultural-based processes. Sasaki et al. [1], found that cellulose could be completely dissolved in water without acids, bases, or other catalysts as mixtures were brought to supercritical conditions. The mechanism of dissolution was surface hydrolysis and homogeneous reaction that gave a product distribution that favored formation of hydrolysis products (cellobiose, erythrose, glucose) rather than pyrolysis products. Other reactive phase behavior studies of popular polymeric materials showed retrograde crystallization, remarkable liquid phase swelling or other phenomena [2-3]. In this work, we examine the reactive phase behavior of cashew nut shell material in supercritical water and some of the cashew nut shell liquid (CNSL) extraction characteristics with supercritical carbon dioxide. Some comparisons are made with liquid solvents.

The cell that we use allows complete view of the full cell contents. Images were recorded by CCD and microscope along with digital video. In one experimental run, the epicarp was placed in water and heated at constant density to 450°C. The shell was found to slowly swell and change shape and finally dissolve into the water phase. Cooling of the solution provided evidence of mostly liquid products. Analyses by laser Raman confirmed the high polysaccharide character and possibility as a feedstock. Detailed analyses are given in the full manuscript.

In the extraction experiments, a flow apparatus was used. Cashew nuts were split open and subjected to contact with supercritical carbon dioxide at 40-60°C. From the initial experiments, the CNSL can be extracted from the honey-combed material. There are at least two possible mechanisms. The first

possible mechanism is the penetration and diffusion of the carbon dioxide into the matrix and subsequent diffusion of CNSL into the bulk phase. Another possible mechanism is that the carbon dioxide penetrates into the natural matrix and partially dissolves into the oil phase. This causes the oil to swell and its viscosity to become greatly reduced. This allows the oil to flow out of the honeycombed matrix and then to diffuse into the bulk phase. To confirm the existence of some of these extraction mechanisms, the swelling of the CNSL in the presence of carbon dioxide is currently scheduled for study in the visual cell. However, opening of samples before completion of the extraction exhibit foaming and bubbling of the liquid phase.

On the basis of our results, we have formed a research group that includes seven countries throughout the world including the Americas. One aspect of this presentation will be to describe their proposed research roles, which includes processing of the entire tree.

Conclusion

On the basis of the experiments of cashew nut materials with supercritical water and supercritical carbon dioxide, it is concluded that processing can be greatly improved for the recovery of the cashew nut shell liquid and the conversion of the shell material to polysaccharide feedstocks. Further research is needed in this area.

References

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